Processing Guide

High Temperature 1901 VP

Easy-to-print material with high heat resistance, good toughness and excellent chemical resistance

Cubic Ink High Temperature 1901 VP with easy and versatile processability shows high printing accuracy. Due to superior thermal and chemical stabilities wit heat deflection temperatures up to 290 °C and not brittleness the material is designed for demanding applications. The formulation also features a favorable regulatory profile, particularly regarding cytotoxicity.

Materials can be used in

Tooling | Machinery | Automotive | Aerospace

Performance Indicators

HDT B	270 °C
Drop Test	Very Good
Chemical Resistance	Superior
Cytotoxicity	Passed

Preparation

Printing

LCD, DLP, mSLA

Washing

1 - 3 min Cleaner 400 or IPA

Post-Curing

Cure with UV or thermally

Preparation

Safety Guideline

High Temperature 1901 VP is a chemical formulation in the liquid state and has to be treated as such until it is fully cured. Please use personal lab protection equipment such as appropriate gloves, goggles and lab coat. Wash contaminated body parts and equipment directly after occurrence and change contaminated gloves immediately. Do not consume the resin.

Danger

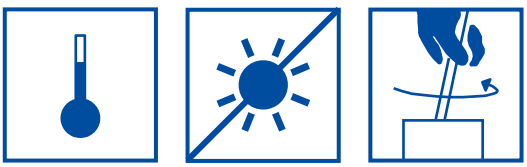
The information given in this document do not constitute a legally binding SDS, which will be provided at purchase.

Storage and Preparation

Please make sure the resin is stored at minimum at 21 °C.

Please make sure the resin is not exposed to light.

Please stir resin prior to use.



Printing

Print Settings

High Temperature 1901 VP printed part properties may vary with printer, print settings, object orientation, part geometry and post-processing. The shown recommendations of printer and print settings are based on Cubic Ink's experiments and experience and do not include all possible processes and feasibility of the material (Table 1 - 3). The processor is welcome to explore the workflow regarding printer and print settings since High Temperature 1901 VP is compatible with a broad range of LCD, DLP and mSLA machines. Nevertheless, Cubic Ink supports and customizes the processing guidelines together with their partners. If not stated otherwise specimens and objects are printed vertically.

Printing

General Curing Parameters

In Table 1 different curing characteristics are presented. The necessary critical energy as well as the penetration of depth indicate the reactivity and curing in depth abilities of the liquid resin. To reach good material properties it is beneficial to have a throughout curing during printing. E.g. High overcure rates are favorable. Please note, that **for the black resin it is not recommended to print layer thicknesses higher than 50 µm**. Please contact us for further information.

Table 1: Curing Parameters measured at Cubic Ink for High Temperature 1901 VP in uncolored and black.

Measurement	Uncolored		Black	
405 nm, 8 mW/cm²:				
E_c [mJ/cm²]	3.21		3.24	
D_p [mm]	0.27		0.17	
Thickness after 1 s of exposure [mm]	0.21		0.15	
Thickness after 4 s of exposure [mm]	0.67		0.40	
385 nm, 11 mW/cm²:				
E_c [mJ/cm²]	4.27		4.22	
D_p [mm]	0.20		0.14	
Thickness after 1 s of exposure [mm]	0.18		0.14	
Thickness after 4 s of exposure [mm]	0.47		0.32	
x-y-Compensation [%]	2.2[1]	1.6[2]	1.6[3]	1.2[4]
z-Compensation [mm]	0.20[1]	0.10[2]	0.05[3]	<0.01[4]
Printable overhangs [°]	up to 20[1]	up to 30[2]	up to 30[3]	up to 25[4]
Minimal wall thickness unsupported [mm]	0.4[1]	0.2[2]	0.4[3]	0.2[4]
Minimal wall thickness supported [mm]	-	0.2[2]	0.4[3]	0.4[4]
Minimum pin thickness [mm]	-	0.5[2]	0.5[3]	0.5[4]
Minimum hole thickness vertical [mm]	1.0[1]	1.0[2]	1.0[3]	1.0[4]
Minimum hole thickness horizontal [mm]	-	2.0[2]	1.0[3]	1.0[4]

[1]Measured with samples printed and cured via Asiga Pro 4K (DLP 385 nm, 11 mW/cm², 100 µm) and 2x 30 min Formcure L 80°C; [2]Measured with samples printed and cured via via Formlabs Form 4 (LCD 405 nm, 11 mW/cm², 100 µm) and 2x 30 min Formcure L 80°C; [3]Measured with samples printed and cured via Asiga Pro 4K (DLP 385 nm, 11 mW/cm², 50 µm) and 2x 30 min Formcure L 80°C; [4]Measured with samples printed and cured via Formlabs Form 4 (LCD 405 nm, 11 mW/cm², 50 µm) and 2x 30 min Formcure L 80°C; For more details, please contact us.

Printing

Print Settings

Table 2: Suggested curing times depending on wavelength, color, printing thickness and intensity of light source for High Temperature 1901 VP.

Wavelength	Color	Layer thickness [µm]	11 mW/cm²	8 mW/cm²	5 mW/cm²	2 mW/cm²
385 nm	Uncolored	50	0.5 s	0.7 s	1.2 s	2.9 s
	Uncolored	100	0.7 s	1.0 s	1.5 s	3.8 s
	Black	50	0.6 s	0.8 s	1.3 s	3.3 s
405 nm	Uncolored	50	-	0.5 s	0.8 s	2.0 s
	Uncolored	100	-	0.7 s	1.1 s	2.8 s
	Black	50	-	0.6 s	1.0 s	2.4 s

High Temperature 1901 VP was tested on several printers such as

Prusa SL1S Speed (LCD, 405 nm, 2 mW/cm²), Phrozen 8K Mighty (LCD, 405 nm, 2 mW/cm²), Phrozen 8K Mega S (LCD, 405 nm, 3 – 5.6 mW/cm²), Asiga Pro 4K80 (DLP, 385 nm, 2 - 11 mW/cm²), Formlabs Form 4 (LCD, 405 nm, 2 - 11 mW/cm²). For more information, please contact us.

Table 3: Examples of print settings at Cubic Ink for High Temperature 1901 VP in uncolored and black.

Printing system	Color	Layer thickness [µm]	Exposure time bottom layer [s]	Exposure time default layer [s]
Prusa SL1S Speed (LCD, 405 nm, 2 mW/cm²)	Black	50	10.0	6.00
Formlabs Form 4 (LCD, 405 nm, 11 mW/cm²)	Uncolored	100	20.2	0.69
	Black	50	18.6	0.44
Asiga Pro 4K80 (DLP, 385 nm, 11 mW/cm²)	Uncolored	100	2.3	0.52
	Black	50	22.2	0.60

Washing

Removing & Washing

- Washing with isopropyl alcohol up to 3 min
- Ultrasonic bath or adequate mixing equipment may be used

- Alternatively, washing with Cubic Ink Cleaner 400 up to 3 min if throughout curing was achieved during printing
- Rinse with IPA

Cleaning

- Treatment with compressed beneficial

Drying

- Let dry at ambient conditions for at least 30 min
- Drying for 60 – 180 min at 50 °C is beneficial

Post-Curing

High Temperature 1901 VP needs to be post-cured to reach its final material properties. The post-cure used on the TDS (Version 3) contained 2 x 15 min UV-treatment via Formlabs Formcure 1st Gen at 80 °C (LED, 405 nm). Other examples of post-curing are shown in Table 4 and 5 to emphasize different effects of UV-curing chambers, wavelengths, intensities, time and additional thermal post-cure.

High Temperature 1901 VP is post-cured via

- **Intense and homogenous UV-cure is necessary**
- Temperature in UV-chamber as high as possible (≥80 °C)
- If possible, use vacuum or nitrogen atmosphere
- Thermal post-cure recommended if low intense light chambers were used to gain full potential of material properties. To avoid cracking the pre-used UV curing needs to be as thoroughly as possible, e.g. due to increased time, temperature during UV post curing or due to increased light dose and overcure during printing.
- **The black resins needs more UV-curing during printing and post-curing to avoid cracking than the uncolored resin.**
- Thermal post-cure is carried out in ventilated oven. Do not place too many parts on the tray to avoid exothermal expansion.

Table 4: UV post-processing carried out at Cubic Ink for High Temperature 1901 VP Uncolored (printed with 50 µm).

Post-Process	E-Modulus [GPa]	Tensile strength [MPa]	Elongation at break [%]	HDT B [°C]
2x 15 min Formcure 1st, 80 °C	**2.5**	**63**	**4.8**	**272**
2x 30 min Formcure L, 80 °C	2.4	56	4.5	270
2x 2000 flashes Otoflash, N_2	1.9	48	6.5	141
2x 6000 flashes Otoflash, N_2	2.3	57	5.1	253
2x 90 min 3D Systems, 60 °C	2.2	54	5.2	200
2x 30 min Hg-lamp	2.1	52	6.5	156
2x 30 min Prusa	1.9	48	7.6	163
2x 90 min Prusa	1.9	49	7.5	202
2x 30 min Prusa + 5 h 100 °C	2.0	52	6.3	217
2x 30 min Prusa + 1 h 130 °C	2.0	49	6.5	161
2x 30 min Prusa + 5 h 130 °C	2.0	51	6.8	218
2x 30 min Prusa + 3 h 150 °C	1.9	45	4.8	295
2x 90 min Phrozen	1.9	48	6.8	168
30 min RSCure, vac.	1.9	49	6.2	238

Formlabs Formcure 1st Gen = LED, 405 nm; Formlabs Formcure L = LED 375, 405 nm; NK Optik Otoflash G171-6 = light-flashes, 350 – 550 nm, N_2; 3D Systems LC-3D post-process unit = 350-550 nm; Hg-lamp = Hönle UVAcube 100; Prusa CW1S = LED 405 nm; Phrozen = LED 405 nm; Rapidshape RSCure = upper + lower wavelength, 170%; thermal post-cure with Memmert UF30 ventilated oven (place only one tray into oven, leave space between objects). Tensile testing Din EN ISO 527-1 5A-specimens, 5 mm/min, 23 °C; HDT B Din EN ISO 75, all specimens printed vertically.

Post-Curing

Table 5: UV post-processing carried out at Cubic Ink for High Temperature 1901 VP Black (printed with 50 µm).

Post-Process	E-Modulus [GPa]	Tensile strength [MPa]	Elongation at break [%]	HDT B [°C]
2x 15 min Formcure 1st, 80 °C	2.2	56	4.4	279
Cleaner 400 Wash, 2x 15 min Formcure 1st, 80 °C	2.2	56	5.0	-
2x 5 min Formcure 2nd, 100 °C	2.4	59	4.7	253
2x 30 min Formcure 2nd, 100 °C	2.5	61	4.3	291
2x 6000 flashes Otoflash, $_{N2}$	2.4	56	4.4	204
2x 90 min 3D Systems, 60 °C	2.3	57	5.5	175
2x 30 min Prusa	2.0	46	5.1	165
2x 30 min Prusa + 5 h 130 °C	2.0	49	6.4	219
2x 90 min Phrozen	1.8	45	6.1	154
60 min Asiga Cure, 80 °C, vac.	2.4	56	4.1	292

Formlabs Formcure 1st Gen = LED, 405 nm; Formlabs Formcure 2nd Gen= LED, 405 nm; NK Optik Otoflash G171-6 = light-flashes, 350 – 550 nm, N_2; 3D Systems LC-3D post-process unit = 350-550 nm; Prusa CW1S = LED 405 nm; Phrozen = LED 405 nm; Asiga Cure 1.5 L = LED, vacuum, UV and temperature simultaneously; thermal post-cure with Memmert UF30 ventilated oven (place only one tray into oven, leave space between objects). Tensile testing Din EN ISO 527-1 5A-specimens, 5 mm/min, 23 °C; HDT B Din EN ISO 75, all specimens printed vertically.

Post-Curing

General Effects of Post-Curing

- Washing and drying:
  - The washing fluid and time of washing can influence the final material properties.
  - In some cases (e.g. using higher temperatures while post-curing) cracks can occur if not washed as recommended and not dried thoroughly.

- UV-Post-cure:
  - Higher wavelength (e.g. ≥405 nm) better for cure in depth, shorter wavelength (e.g. ≤365 nm) better for surface cure.
  - Broad spectra light sources or the combination of multiple wavelengths improve the overall curing process.
  - The higher the intensity of a light source, the shorter the time in the curing chamber.
  - Part orientation in the chosen UV-chamber is crucial. Most chambers focus the LED-spots in the middle of the volume. Placing flat objects on the bottom may cause nearly no or less irradiation by light. Curing time may need to be adjusted depending on the geometry of the part.

- UV Post-cure with vacuum or nitrogen atmosphere:
  - Better for surface cure. Decrease of time in UV-chamber.
  - Less stickiness.

- UV-Post-Cure with simultaneously temperatures above 60 °C:
  - Good for cure in depth and surface cure. Decrease of time in UV-chamber.
  - Not that much depending on the color and geometry of the part, the effect of temperature influences the homogeneity of curing.

- Additional thermal post-cure after finished UV-cure:
  - Good for final cure in depth and surface cure.
  - Recommended temperature varies between 80 - 130 °C for 1 – 5 hours for most materials, between 130 - 190 °C for 0,5 – 5 hours for very high temperature resistant materials.

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